

NextGen Stress & Fracture for Lightweight Structures

Completed Technology Project (2016 - 2016)



Project Introduction

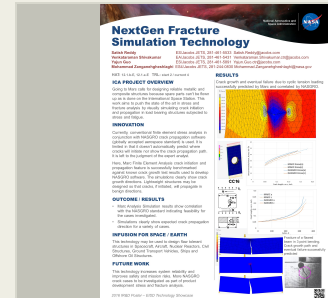
The dream in stress and fracture analysis has always been to be able to simulate cracks initiating and then propagating in a stress field in a metal or composite structure. To date, the engineer is only able to see a stress plot that identifies highly stressed problematic areas. Only a stress and fracture expert may be able to accurately figure out where cracks will initiate and in which direction it will propagate. The latest tools now give this ability but have not been widely used or accepted in aerospace. This effort would benchmark the latest tools with accepted standards in aerospace and seek to develop appropriate techniques to develop highly visual simulations of cracks initiating and propagating. These techniques will help us to engineer far more robust aerospace structures mitigating risk to the mission and crew. This is critical for a Mars mission where reliability of hardware is paramount.

NASGRO (NASA Crack Growth Software) is the globally used (Boeing, Lockheed, NASA, ESA, Airbus, Bombardier, Embraer,...) aerospace standard for fracture analysis. It uses an extensive test data base to develop predictive crack growth models. Finite element models of these crack cases will be built and analyzed using Marc's new powerful crack initiation and propagation features. These will be compared to NASGRO results and techniques will be developed to ensure greatest correlation. These techniques will be applied to complex geometry with the final goal of making a crack, when it occurs, grow in a benign direction. These techniques and results will be published enabling the aerospace industry to develop far more reliable structural components. Marc also simulates delamination in composites very visually.

A report detailing the crack cases studied, correlations between NASGRO and Marc FEA, videos showing how the cracks grow. For complex geometries, the video showing how the cracks grow will be very educational in designing such crack arresting features. Crack growth rates and growth directions may be studied for different applied loads. The Marc analysis settings that will give the best correlations will be documented.

Anticipated Benefits

Ideas learned from this work may be used to propose funding to improve NASGRO, collaborate with Marc, or may see other revolutionary techniques in stress and fracture analysis. Meanwhile, the intent is to begin using this technology on flight hardware at JSC (the principal investigator is Chief Engineer for Structural Analysis at Jacobs) and gain experience before publishing the findings in technical journals. Experience gained here will help qualify the methods for future use.



NextGen Stress & Fracture for Lightweight Structures
Technology Showcase 2016
Project Poster

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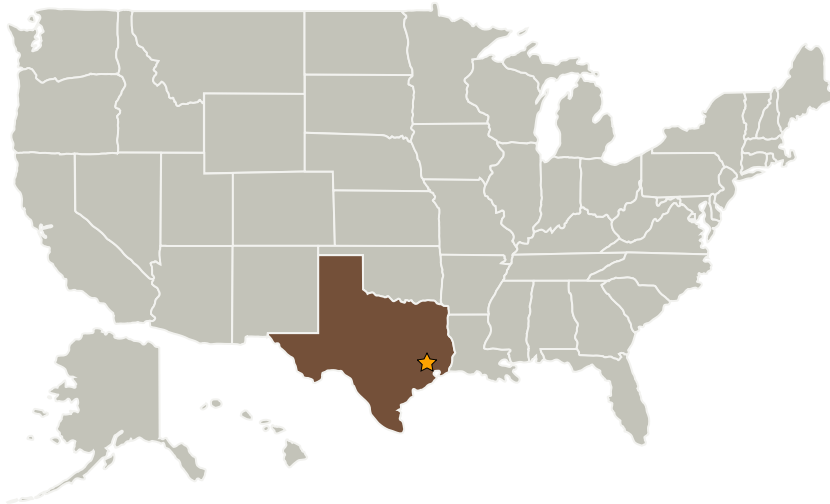
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Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations

Texas

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Center Independent Research & Development: JSC IRAD

Project Management

Program Manager:

Carlos H Westhelle

Project Manager:

Satish C Reddy

Principal Investigator:

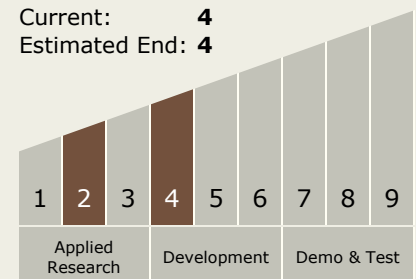
Satish C Reddy

Technology Maturity (TRL)

Start: 2

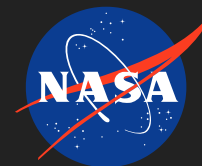
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Estimated End: 4

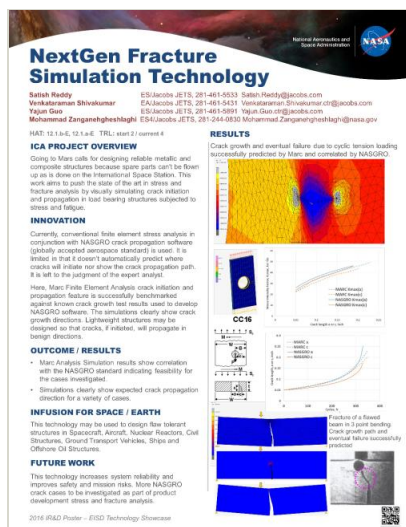


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Images



NextGen Stress & Fracture for Lightweight Structures Project

NextGen Stress & Fracture for Lightweight Structures Technology Showcase 2016 Project Poster (<https://techport.nasa.gov/image/26141>)

Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
 - ↳ TX12.3 Mechanical Systems
 - ↳ TX12.3.3 Design and Analysis Tools and Methods